NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

EFFECCTIVE USE OF COLLABORATIVE INFORMATION TECHNOLOGY TO ENHANCE GROUP PERFORMANCE

by

Patrick Gallaher
and
Julie O'Rourke

September 2004

Thesis Advisor: Thomas Housel
Second Reader: Paul Pavlou

Approved for public release; distribution is unlimited

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE		*Form Approved OMB No. 0704-0188*

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.

1. AGENCY USE ONLY (*Leave blank*)	2. REPORT DATE September 2004	3. REPORT TYPE AND DATES COVERED Master's Thesis	
4. TITLE AND SUBTITLE: Effective Use of Collaborative Technology to Enhance Group Performance		5. FUNDING NUMBERS	
6. AUTHOR(S) Patrick Gallaher and Julie O'Rourke			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000		8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A		10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited		12b. DISTRIBUTION CODE	

13. ABSTRACT (maximum 200 words)

   This research was inspired by the need to create a universal net-centric environment to enable collaborative defense capabilities and deliver knowledge dominance to the DoD. Since superior information management and the use of collaborative IT technologies is fundamental to building intelligence capabilities, this study aims to contribute to the optimization of collaborative system use by military groups and organizations.

   The proposed research model illustrates and explains the direct relationships between collaborative IT competence and collaborative functionalities, which can be used not only to assess current technologies but also aid in requirements generation for designing the ideal collaborative tool suite. Central to the research model we introduce the concept of collaborative IT competence, defined as the effective use of collaborative functionalities, and explore its relationship to performance outcomes.

   Having pre-tested and validated the proposed research model by means of empirical data collection in the form of an end-user survey instrument we recommend further research be conducted on a Navy-wide scale to evaluate the 181 collaborative technology tools currently in use. End-user/warfighter insight will dramatically influence future CIT investment decisions by providing decision makers critical information regarding the pragmatic versus the advertised attributes of the application/tool suite. Additionally, this model is designed to provide the road map to the ideal combination of core functionalities and required collaborative IT competence.

14. SUBJECT TERMS E-Mail Overload, Information Technology, IT, E-Mail, Net-Centric Environment, Collaboration, Collaborative Information Technology			15. NUMBER OF PAGES 55
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

i

THIS PAGE INTENTIONALLY LEFT BLANK

**EFFECTIVE USE OF COLLABORATIVE INFORMATION TECHNOLOGY TO
ENHANCE GROUP PERFORMANCE**

Patrick K Gallaher
Major, United States Marine Corps
B.A., University of California, 1989

Julie E. O'Rourke
Lieutenant Commander, United States Navy
B.A., Villanova University, 1989

from the

**NAVAL POSTGRADUATE SCHOOL
September 2004**

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT

Authors: Patrick Gallaher

                  Julie O'Rourke

Approved by: Thomas Housel
                  Thesis Advisor

                  Paul Pavlou
                  Second Reader

                  Dan C. Boger
                  Chairman, Department of Information Sciences

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

This research was inspired by the need to create a universal net-centric environment to enable collaborative defense capabilities and deliver knowledge dominance to the DoD. Since superior information management and the use of collaborative IT technologies is fundamental to building intelligence capabilities, this study aims to contribute to the optimization of collaborative system use by military groups and organizations.

The proposed research model illustrates and explains the direct relationships between collaborative IT competence and collaborative functionalities, which can be used not only to assess current technologies but also aid in requirements generation for designing the ideal collaborative tool suite. Central to the research model we introduce the concept of collaborative IT competence, defined as the effective use of collaborative functionalities, and explore its relationship to performance outcomes.

Having pre-tested and validated the proposed research model by means of empirical data collection in the form of an end-user survey instrument we recommend further research be conducted on a Navy-wide scale to evaluate the 181 collaborative technology tools currently in use. End-user/warfighter insight will dramatically influence future CIT investment decisions by providing decision makers critical information regarding the pragmatic versus the advertised attributes of the application/tool suite. Additionally, this model is designed to provide the road map to the ideal combination of core functionalities and required collaborative IT competence.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS

AVE   Average Variance Extracted

CIT   Collaborative Information Technology

I&KA   Information and Knowledge Advantage

IT   Information Technology

ITC   Information Technology Competence

NCW/IS   Net Centric Warfare and Information Superiority

PBC   Perceived Behavioral Control

PLS   Partial Least Squares

SN   Subjective Norm

TPB   Theory of Planned Behavior

VIF   Variance Inflation Factor

THIS PAGE INTENTIONALLY LEFT BLANK

ACKNOWLEDGMENTS

THIS PAGE INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY

This study examines the potential benefits of collaborative technologies on group performance, captured with (a) project efficiency, (b) project effectiveness, (c) satisfaction, (d) shared situational awareness, (e) improved decision-making, and (f) reduced information overload. This study originally intended to address the symptoms and causes of the email overload issue within DoD evolved from a request initiated by LCDR James Mills of the Navy Information Professional Community and is sponsored by Dave Wennegren, Department of the Navy, Chief Information Officer. However, e-mail overload is only one of the factors contributing to a much larger information management problem among collaborative work groups. This bigger picture problem is what this thesis aims to address with the aid of collaborative technologies.

A research model was designed and pre-tested that identifies the individual and collective variables that influence collaborative system use. The model is composed of Individual and Collective Variables, which are factors of the Collaborative System in Use. The combination of Collaborative IT Competence and Collaborative Functionalities result in the five unique Group Performance Outcomes influenced directly by individual and system Control Variables. This study presents some of the factors, influences and relationships, which begin to explain the complex dynamics of collaborative system use.

The research model was tested with a web-based survey questionnaire. The survey response period was seventeen days – 17 August 2004 through 3 September 2004. The respondents were asked to answer questions in regards to a specific named project that they had recently managed or participated in using collaborative technology tools. The subject population of primary contacts in this study totaled 39 collaborative technology managers and 120 Information System Technology graduate students at the Naval Postgraduate School. Fortunately the model proved predictive in spite of the small sample size and target response rate of 23%. Specifically, the results reveal that collaborative IT competence significantly influences all four performance measures, explaining a substantial amount of their variance. In turn, three predictor variables – perceived ease of use, computer self-efficacy, and system customization – are the primary

antecedents of collaborative IT competence. The research model demonstrated there was a strong correlation (.80) for a perceived reduction in email overload by using CIT.

This study presents an initial step towards better understanding the individual and collective variables that directly influence collaborative system use. It also establishes a critical link and feedback loop that includes all stakeholders of the CIT environment process. The net result of this new interaction being decision makers make better informed decisions by effectively empowering every end user to influence their environment by being a part of the process. Other benefits include the ability to foster and encourage the effective use of collaborative technology as well as provide insight into design enhancements of future collaborative capabilities. The ultimate practical contribution of the final research model then becomes a direct contribution to the eventual CIT universal defense capability and policy. Based on this successful pre-test of the research model, it is recommended the research model/survey tool be used on a significantly larger subject population. This will allow for additional analysis of additional contributing factors that influence collaborative system use.

I.   MOTIVATION

Today's Navy needs everything a network-centric force offers in theory, acquiring the ability to fully exploit technological advances by gathering and sharing accurate and appropriate information, building situational awareness and achieving decision superiority is the ultimate goal. This thesis is aimed at better understanding some of the critical issues related to this effort. Specifically the proposed theory-driven research model is tested using a survey methodology to determine the degree to which Collaborative System Use influences performance outcomes. Analysis of the relationship between 'collaborative IT competence' and performance presents the ability to identify the factors that directly influence group productivity. Wide-scale utilization of this research model would enable the Navy and DoD as a whole to assess which collaborative functionalities and in what combination are critical to group success.

This thesis originates from a project to address the DoN e-mail overload problem. However, e-mail overload is a symptom of a much larger information management dilemma among work group members. As capabilities in Collaborative Information Technology (CIT) have evolved and progressed, the ability for individuals to coordinate and ultimately collaborate in their efforts has become both essential. One of the many problems facing organizations is the question of which technologies and in what combination to field them to achieve the best returns. Email and its expanding misuse is a prime example of how one of the early tools by itself has proven to not scale well, not obtain the desired effects, and has lead to more confounding problems.

The evolution of CIT capabilities is being driven by both needs and wants simultaneously. After the events of September 11, many organizations were driven to CIT solutions out of necessity to reestablish some semblance normalcy. The Navy's vision for the future and the development of its Net Centric Warfare and Information Superiority (NCW/IS) concept are dependent on CIT working well. CIT has the potential for providing significant returns in costs reduction, timesavings, quality of work produced, and creativity.

1

We propose the definition of 'collaborative IT competence' and its interaction with several key collaborative functionalities to introduce the concept of Collaborative System Use as the engine that fuels specific group performance outcomes. By improving the quality and speed with which members of an organization can exchange information there will be an improvement in the overall knowledge management environment. Given the highly desirable benefits of inter-disciplinary collaboration and team decision-making, this study aims to shed light on the driving factors within collaborative technologies on group performance.

A.   RESEARCH QUESTIONS

Relevant literature concerning collaborative information technology supports the argument that defense groups can enhance their mission performance through collaborative technologies and can provide seamless integration among group members to assure that correct, timely, and protected information to the right person anywhere, anytime. These collaborative capabilities can help enhance warfighter situational awareness, ensure information access, optimize knowledge resources, build integrated solutions, and adopt best practices across groups (NWDC IKA 2004). The existing research supports the efforts to establish a baseline understanding of the productivity and efficiency gains to be realized through the use of collaborative technology.   The following research questions are designed to gather and facilitate the understanding of current collaborative technology tools/applications in use DoN-wide.

- Whether, how, and why collaborative technologies can improve group performance outcomes (e.g. efficiency, effectiveness, satisfaction, situational awareness, reduction in email overload)?

- How do organizations achieve the potential benefits of collaborative technologies?

- What individual and group factors drive the effective use of collaborative technologies?

B.   RESEARCH MODEL

The following model will be used to address the research questions. Specifically the research model provides a proof of concept methodology for determining how Collaborative IT Competence can facilitate performance benefits.   The model is composed of Individual and Collective Variables, which are factors of the Collaborative System in Use. The combination of Collaborative IT Competence and Collaborative

Functionalities result in the five unique Group Performance Outcomes influenced directly by individual and system Control Variables.
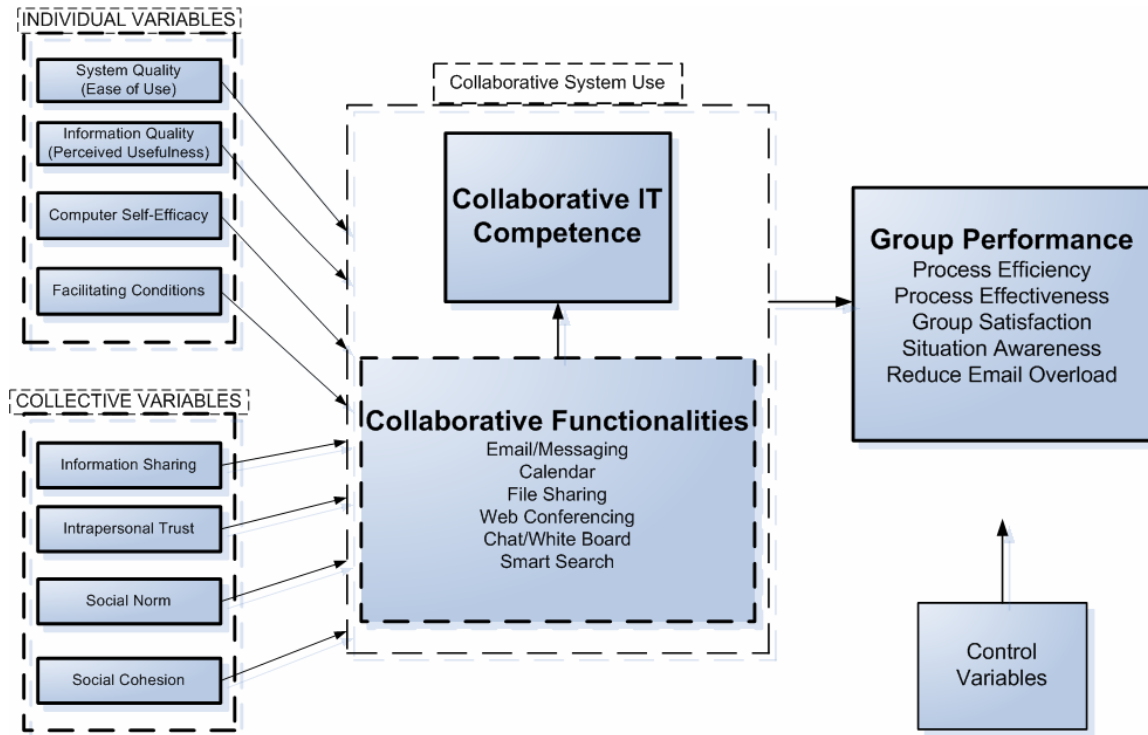
Figure 1.   Research Model

THIS PAGE INTENTIONALLY LEFT BLANK

II.   THEORY DEVELOPMENT

A.   LITERATURE REVIEW

The ubiquity of the Internet's connectivity brings together widely dispersed entities to enable collaboration in places where it was not feasible before, resulting in the emergence of 'online collaborative work', which has transformed the established nature of traditional collaborative work and sparked increased academic and practical interest (e.g., Easley, Devaraj, and Crant, 2003).

Sophisticated collaborative technologies, such as Groove Networks and Oracle Collaboration Suite are a relatively recent development. These technologies are integrated sets of collaborative functionalities that enable synchronous and asynchronous communication and information sharing among inter-connected entities. Despite the widely publicized potential of these collaborative technologies to develop dynamic capabilities to adapt to information-intensive environments, we still know little whether, how, and why these technologies can enhance group productivity (e.g., project efficiency and effectiveness, situational awareness, group satisfaction, email overload).

B.   COLLABORATIVE WORK

Collaborative work is considered the foundation of any organization's success. Therefore, research on collaborative work and its impact on team and organizational performance has been prominent. Recent IT advances have enabled collaborative systems that aim to facilitate and support collaborative work. Evidence suggests that these technologies are widely adopted in practice. Nevertheless, we still know little whether, how, and why collaborative technologies can enhance group capabilities and performance.

C.   COLLABORATIVE TECHNOLOGIES

Collaborative technologies are integrated set of IT-enabled functionalities that enable synchronous and asynchronous communication and information sharing among inter-connected entities from virtually any geographical location. Today's collaborative technologies are more sophisticated versions of computer-supported 'Group Communication Support Systems', 'Group Decision Support Systems', or 'groupware', which are computer aids designed to support collaborative work.

While there is a long history of collaborative technologies (Licklider and Taylor, 1968, Nunamaker, Dennis, and Valacich, 1991), Internet-based technologies are becoming the most prominent in practice, especially among dispersed groups (Wheeler, Dennis, and Press, 1999). Effective use of collaborative technologies enables groups to communicate, collaborate, and interact, facilitating dispersed interaction across time and space (Sole and Applegate, 2000).

1.   Functionalities in Collaborative Technologies

Common collaborative functionalities include email/messaging, calendar, file-sharing, voice and audio conferencing, whiteboards and shared workspaces, and smart search, among others. If these functionalities are effectively used, they can support brainstorming and sharing of new ideas (Hamilton 2001, Molloy and Schwenk, 1995), constructing project histories (Grantham and Nichols, 1993), and reaching group consensus (Rockart and Short, 1989), among other positive outcomes. The effective use of these key functionalities jointly determines the group's 'collaborative IT competence'.

D.   COLLABORATIVE IT COMPETENCE

Since the IT artifact is still not well-defined (Orlikowski and Iacono, 2001), to better understand the impact of IT on dynamic capabilities, we propose the concept of 'collaborative IT competence'. Following Sambamurthy et al., (2003), 'collaborative IT competence' is defined as 'the ability to acquire, deploy, and leverage collaborative functionalities in combination with other resources to support collaborative activities in value adding ways'. Other resources include, but are not limited to human, managerial, and organizational resources, plus other IT functionalities and technologies. We propose the combination of the use of Collaborative Functionalities and Collaborative IT Competence will have positive influence on five performance outcomes; Process Efficiency, Process Effectiveness, Group Satisfaction, Situational Awareness, and Reduction in Email Overload.

Collaborative IT competence is distinguished from related constructs (King, 2002). First, IT competence captures effective management of collaborative *IT functionalities*, not merely their existence (Wiseman, 1988). Second, *IT investments* do not necessitate that proper collaborative IT systems will be acquired, integrated, and managed (Feeny and Willcocks, 1998).

6

IT competence has been generally a multi-dimensional construct (Bharadwaj, 2000). For instance, Ross et al., (1996) argue that IT competence is developed along multiple dimensions. Feeny and Willcocks (1998) also propose nine IT functionalities for business success. Collaborative IT competence is composed of seven representative (non-exhaustive) facets (Table 1).

Effective Use of Collaborative Functionalities
Effective Use of Email Functionality
Email to exchange messages among team members.
Effective Use of Chat/Instant Messaging Functionality
Chat/Instant Messaging to share information in real-time.
Effective Use of Calendar Functionality
Calendar for connecting time and location information for all team members
Scheduling for providing up-to-date calendar information.
Effective Use of File-Sharing Functionality
File sharing to store, archive, and reuse information and best practices.
Consolidation and synchronization of files into a single repository for easy access.
Effective Use of Conferencing Functionality
Conferencing for spawning new ideas and solutions.
Collaboration among team members to interact in real time.
Effective Use of Whiteboard/Shared Workspace Functionality
Shared workspace for simultaneously working together in real-time.
Whiteboard functionality for bringing together team members.
Effective Use of 'Smart' Search Functionality
Search functionality for quickly locating information and files.
Search functionality for enabling quick access to content.

Table 1.   Operationalization of Collaborative IT Competence

Following the notion of 'product convergence' (Mantena and Sundarajan, 2002), these seven functionalities are more effective when all of them are simultaneously used due to their complementarities (Kraut and Streeter, 1995). Collaborative IT competence captures the inter-relationships among these functionalities under a parsimonious construct to explain their joint influence on collaborative processes.

E.   IT COMPETENCE & GROUP PERFORMANCE

Collaborative ITC will allow organizations to complete tasks better, faster, and cheaper. For the military increased collaborative ITC will be a key enabler for generating and sustaining combat power and controlling the operational tempo in the future network centric-warfare environment. Process efficiency consists of project time and development cost (Kusunoki *et al.*, 1998). Second, product effectiveness consists of project quality and innovativeness. Finally, situation awareness reflects the group's

ability to understand their environment and enhance collective decision making. Through effective coordination, learning, and collective mind with the aid of collaborative IT competence, groups can enhance these performance outcomes. In sum, collaborative IT competence enhances group innovation, flexibility, responsiveness, and collaboration (McGrath and Iansiti, 1998).

1.   **Process Efficiency; CIT Enabling Faster and Cheaper Processes**

CKE Restaurants, the parent company of Carl's Jr., Hardee's, La Salsa, Green Burrito and Timber Lodge Steakhouse restaurants expects to be able to reduce the amount of time spent on creation and editing corporate training materials by more than fifty percent (Communication News, 2003). Proctor and Gamble by using CIT and alternative workplace arrangements aimed to reduce its real estate costs by $300 million annually (Harmon, 2001). In a military setting when a task force embarked on board naval shipping begins a rapid mission-planning scenario significant amounts of time and effort is expended just trying to centrally locate all of the key planners from within the task force on a single ship.   With the use of CIT these key planners can get their mission specific orders and begin planning immediately, allowing for a jump-start of the process in a time critical scenario.

2.   **Process Effectiveness; When Being Geographically Collocated is Not an Option**

In the case of Morgan Stanley, the largest tenant in tower number two of the World Trade Center, they employed over three thousand people on multiple floors. When the towers collapsed, they were faced with two situations that required their immediate attention. First, how to reestablish functional operations to temporarily carry the burden of the offices lost in the towers collapse. Second, once they were able to reestablish local offices in the Manhattan area connecting various entities in the greater Manhattan area that were no longer centrally located in a single building. Morgan Stanley claims they were operational within 48 hours and they achieved this result by relocating people to backup facilities in New Jersey and Brooklyn (Tully, 2001). One of the core principles for survival on the battlefield is dispersion. Commanders constantly face the challenge of balancing the need for dispersion; to minimize the effects of any one of the enemy's weapons systems, and the need to mass ones own forces to achieve desired outcomes. By using CIT, modern commanders have the ability to exercise maximum dispersion

physically yet be virtually collocated for planning and coordination allowing for the actual massing of forces at the decisive time of action.

3. Group Satisfaction; Unique Solutions to Traditional Challenges

The perception that air travel is a stable, secure, reliable transportation system was given a significant jolt on September 11, 2001. Air travel was and is still one of the safest modes of transportation on the face of the earth but the world model has been subject to some significant adjustment in the aftermath of the September 11 attacks. With the changes in security screening, vehicle procedures at airports, curbside check of baggage, reductions in numbers of flights, air travel became significantly less convenient. With the significant eroding of the public confidence in the safety of the airline industry and its ability to prevent a repeat of the events September 11th, many organizations have been looking for alternative solutions to the traditional in person business meeting. CIT has presented solutions that have a unique and significant positive impact on the perceptions on the group as a whole.

4. Situational Awareness; Higher Degree of Knowledge Sharing

The ability for multiple members of a work group to have an up to date vision of the state of a project can is significantly enhanced by CIT. With file sharing and web conferencing groups can spread out over a large geographic area can simultaneously download, view, edit and discuss project documents or presentations. All of the team members are able to update their vision of the projects status and rapidly resolve any ambiguities or areas of contention in a real time environment.

5. Organizational Performance; Increases in Creativity

Design teams from multiple organizations are able to brainstorm and coordinate their efforts from hundreds to thousands of miles away. In addition since problems are not necessarily limited to specific disciplines or schools of thought, new and creative perspectives can be brought to the table that otherwise might have been ignored, overlooked, or never sought out.

F. IMPROVING THE PERCEIVED EFFECTIVENESS OF COLLABORATIVE TECHNOLOGIES

Having shown the impact of collaborative technologies on group performance, the next step aims to prescribe how their effective use can be enhanced by understanding which individual and collective factors drive the effective use of collaborative systems.

Following an extensive literature review we identified a group of factors that drive the effective use of collaborative technologies.

The rationale for the antecedents of collaborative IT competence is based on Ajzen's (1985, 1988, 1991) Theory of Planned Behavior (TPB), which has been one of the most influential theories in explaining and predicting human behavior. According to TPB, the proximal determinant of a *behavior* is a behavioral *intention* - after all, people do what they intend to do. Behavioral intentions are motivational factors of how hard people are willing to try and how much of an effort they are planning to exert to perform a behavior (Ajzen 1991, p. 181). Behavioral intention, in turn, is determined by three factors: perceived *attitude* toward the behavior, perceived *subjective norm* (SN*)*, and *perceived behavioral control* (PBC). Attitude captures the overall evaluation of the desirability of the behavior, SN refers to the expectations of important others with regard to the behavior, and PBC refers to the ease or difficulty of performing the behavior. The antecedents of attitude, SN, and PBC are a set of underlying attitudinal beliefs, normative beliefs, and control beliefs, respectively.

1. Individual IT antecedents

Following Venkatesh et al., (2003), individual acceptance and use of IT is driven by four factors:

a. Perceived Usefulness

Perceived usefulness is defined as the extent to which a system user believes that using a system will enhance her job performance (Davis, 1989). It enables accomplishing tasks more quickly, improving job performance, and increasing productivity. Perceived usefulness improves a user's attitude toward using a collaborative system, thus facilitating its effective use.

b. Perceived Ease of Use

Perceived ease of use or system quality is defined as the extent to which a system user believes that using the system will be effortless (Davis, 1989). It reflects whether a system is clear and understandable, intuitive, and does not require a lot of my mental effort. Perceived ease of use also improves a user's attitude toward using a collaborative system, also facilitating its effective use.

c. *Computer Self-Efficacy*

Self-efficacy generally reflects individual judgments of a user's capabilities to perform a behavior (Bandura, 1997). Computer self-efficacy reflects the extent to which a user can use a system with minimal assistance (Compeau and Higgins, 1995). If a user can complete a job using a collaborative system with no or minimal assistance, he is more likely to use the system effectively.

d. *Facilitating Conditions*

Facilitating conditions or controllability reflects individual judgments about the availability of resources and opportunities to perform a behavior (Ajzen, 1991).

Applied to collaborative technologies, it reflects whether a user has the knowledge, resources, and opportunity to use a system. Facilitating conditions thus enables a user to use a collaborative system effectively.

2. Collective IT Antecedents

In addition to individual factors, given the group nature of using collaborative technologies, several other collective factors are likely to facilitate the effective use of collaborative systems.

a. *Trust in Interpersonal Trustworthiness*

Intra-group trust reflects the extent to which group members trust each other. Trust also captures whether promises to each other are reliable, whether group members are honest to each other, and whether they would go out of their way to help each other. Trust improves the attitude toward a behavior, thus facilitating groups to use a collaborative system collectively.

b. *Information Sharing*

Information sharing reflects the extent of information and knowledge exchange within group members. It captures satisfaction with the knowledge exchanged within the group and comfort with sharing sensitive information with group members. If groups openly share information, they are more likely to use collaborative technologies effectively.

c. *Social Cohesion*

Social cohesion represents whether group members are friendly and have good interpersonal relationships (Sethi et al., 2001). Social cohesion enables group

members to work together well without interpersonal conflicts, and it thus allows groups to effectively use a collaborative system.

d. *Social Norm*

Social or subjective norm refers to the judgments of important others with regard to a behavior. It also reflects whether important others actually undertake the behavior (Ajzen, 1991). Following Ajzen, the higher the social norm, the more likely groups will use a collaborative system.

G. CONTROL VARIABLES

System Voluntariness has to do with the level of mandatory use of the technology in order to complete ones assigned tasks as (Venkatesh, 2000). Groups who are forced to use a particular system may behave differently from those who have freedom in choosing to use it or not. While initial utilization may start higher, creativity may be repressed and resentment toward forced change is a likely outcome

Personal Habits for the use of the system has to do with the willingness of users to make it part of the users regular routine (Limayem and Hirt, 2003). Habit can be one of the factors driving the use of collaborative technologies beyond the proposed IT antecedent factors.

In addition, previous training on the use of various tools and system customization to a specific task were indicated by the review of the literature as being meaningful to the use of IT. We expect superior training to result in higher collaborative IT competence and group performance.

System customization could also have an influence on IT competence by allowing users more in depth input to how the system performs specific tasks. The ability to take a off the shelf software package and customize it to an organizations particular needs could be significant to ITC.

III.   RESEARCH METHODOLOGY

A.   SURVEY ADMINISTRATION

Research was primarily conducted on collaborative technologies used within DoD. Given the volume of collaborative technology applications currently in use, only seven core collaboration functionalities were selected for analysis. The selected core functionalities were based on input of a DoD-wide consensus as reported by Sahar Tamen July 2004. The seven functionalities; email, chat/instant messaging, calendar, file-sharing, web conferencing, whiteboard/shared workspace, 'smart' search functionality were in turn studied to determine their direct relationship to enhancing collaboration, group productivity, and situational awareness amongst group members.

We used 'key informant' methodology relying on a single participant to offer information about a collective setting user perspective to establish connections between specific collaborative tool functionality and user productivity. The subjects for this data collection are DON collaborative technology stakeholders and users. These individuals were identified as key managers of government and industry collaborative technology users. Each was initially contacted based on their known use of specific collaborative tools. The subject population expanded as primary points of contacts referred other known managers and users.

The population of primary contacts in this study totaled 39 collaborative technology managers and 120 Information System Technology graduate students at the Naval Postgraduate School. The survey was completed by 57 respondents and 37 collaborative technology users - a total response rate of 36%, however only a 23% effective response rate.

Upon launch of the survey each manager was contacted via email and instructed that a participant invitation survey would follow shortly. Each manger was asked to preview and take the survey then forward the participant survey invitation via their distribution channels to collaborative technology users within and working with their organization. Follow up contact was made one week after launch of the survey via email and phone calls. Follow up phone calls revealed many managers did not distribute the

survey as requested. Per Department of Defense Instruction Number 1100.13, we were not permitted to mass distribute this survey instrument to other DoD components.[1]

As the survey content was web-based and access was acquired via a URL link provided in the email invitation to participate in the study. The survey was broken into six sections. In section one of the survey respondents are asked to identify a typical (not the most or least successful) project that they recently managed and answer the survey questions relative to that experience. The following identifiers were requested from each individual: project title, number of individuals in group, and position within group. Sections two through five contained all measurement items and the last section of the survey consists of six questions requesting general demographic information about the respondent. Additionally, the respondents were provided a text field for additional comments and each respondent was asked if they desired receive an executive summary of the results and the thesis resulting from this study, if so they were required to provide their email. The purpose of acquiring this professional information is to categorize the respondent population.

The data was collected by measurement items based on a series of questions formatted for check box, rating button, and short answer responses. The survey response period was seventeen days – 17 August 2004 through 3 September 2004. The goal was to survey individuals who had utilized collaborative technology in a group setting; those that were not users were directed to the end of the survey and thanked for their time.

B. MEASUREMENT DEVELOPMENT

Wherever possible, measurement items were adapted from existing scales. For new measures and for those that required significant deviations, standard scale development procedures were used (Straub, 1989). First, the domain of each construct was specified. Second, a large pool of items was developed based on the conceptual definition, assuring that these items tap the construct's domain. From this pool, items were chosen based on whether they conveyed different, yet related shades of meaning

---

[1] The distribution of this survey was limited by Department of Defense, INSTRUCTION NUMBER 1100.13, Dated: November 21, 1996, SUBJECT: Surveys of DoD Personnel. This Instruction governs all surveys of DoD personnel, members of the Military Services and their families, as well as surveys conducted by the DoD Components of personnel in other Federal Agencies and members of the public, when the results are to be used for general statistical purposes.

(Churchill, 1979). Aside from control variable and demographic data questions, all questions were structured on a 'Liker-type' scale: one (lowest) to seven (highest). Measurement items are listed in Appendix A.

Collaborative IT Competence: Collaborative IT competence was measured based on a review of the literature that aimed to assess the extent to which group members effectively use IT functionalities. Special care was taken to tightly link IT functionality with specific processes (Lind and Zmud, 1995). The effective use Effective Use of the Collaborative System was measured with twelve newly developed items following the work of (Pavlou and El Sawy, 2004).

Performance Indicators: Project Efficiency and Project Effectiveness were measured with two items each both based on (Kusunoki et al., 1998). Situational Awareness was measured with three items based on (Endsley, 1996). Satisfaction was measured with two items based on (Rai, Lang, and Welker, 2002). Collaborative System Use was measured with five items specifically designed for this study to gather information regarding individual behavior patterns with relation to collaborative system use. Perceived Usefulness was measured with three items, based on (Venkatesh, 2000). Ease of Use was measured with three items, following (Rai et al., 2002; Venkatesh, 2000). Computer Self-Efficacy was measured with five items, based on (Compeau and Higgins, 1995). Facilitating Conditions was measured with two items, based on (Venkatesh, 2000).

Group Dynamics: Beliefs in Interpersonal Trustworthiness was measured with four items, based on (Jap, 1999). Information Sharing was measured with two items, based on (Beccara-Fernandez and Sabherwal 2001; Bensaou and Venkatraman, 1995). Social Cohesion was measured with two items, based on (Sethi et al., 2001). Social Norm was measured with two items, based on (Ajzen, 1991) and Environmental Uncertainty was measured with one item, based on (Pavlou and El Sawy, 2004b).

THIS PAGE INTENTIONALLY LEFT BLANK

IV. RESULTS AND DISCUSSION

We used the Partial Least Square (PLS) method to analyze our data. PLS employs a component-based approach for estimation purposes (e.g., Lohmoller, 1989), and places minimal restrictions on measurement scales, sample size, and residual distributions (Chin et al. 2003). In general, PLS is better suited for explaining complex relationships as it avoids two serious problems: inadmissible solutions and factor indeterminacy (Fornell and Bookstein, 1982). This sentiment is further echoed in (Wold, 1990), who writes: "In large, complex models with latent variables PLS is virtually without competition." (p. 590). In sum, we chose the PLS method in order to accommodate the large number of principal constructs in our model.

A. DESCRIPTIVE STATISTICS

Demographic information is shown in Table 2 (group and respondent characteristics).

Variables	Group Size	Group Experience with collaborative functionalities (months)	Gender (% males)	Age (years)	Education	Work Experience (years)
Mean (STD)	418 (1,918)	13.1 (17.4)	89 (32)	37.1 (8.5)	Some College	16.1 (9.3)

Table 2.   Group and Respondent Demographic Characteristics

About half of the respondent groups used Groove (27%) and Navy Knowledge (23%). Other collaborative technologies used included Oracle (8%) and Autonomy (5%). However, 29% of the respondents reported using more than one packages.

Forty-five percent of the key informants noted their role as leader or manager, and 55% as member or participant. Their key functions were military (40.5%), Information Technology (38%), Sales (8%), and Engineering (13.5%). In terms of training received, 64% received no formal training, 18% received classroom training, 12% received hands-on training, and 6% received online training. Finally, the respondents self-reported level of experience was novice (22%), intermediate (46%), advanced (22%), and expert (5%).

The total number of completed usable responses was 37 out of the 122 respondents we contacted (35% response rate). Non-response bias was assessed by verifying that early and late respondents were not significantly different (Armstrong and Overton, 1977). The first set of tests compared gender, age, education, education, and work experience. The second set of tests compared group characteristics (size and experience with collaborative technology). All t-test comparisons between the means of the two groups in both sets of tests showed insignificant differences (p<0.1 level).

Descriptive statistics and the correlations among the principal constructs are shown in Table 3.

		Mean	STD	1	2	3	4	5	6	7	8	9	10	11	12
1	Group Effectiveness	5.68	1.44	.93											
2	Situational Awareness	5.34	1.91	.823**	.85										
3	Email Overload	4.45	1.72	.651**	.669**	.92									
4	Collaborative Competence	4.39	3.23	.782**	.724**	.652**	.94								
5	Perceived Usefulness	5.28	2.83	.554**	.588**	.736**	.559**	.98							
6	Perceived Ease of Use	5.10	2.86	.562**	.602**	.685**	.590**	.585**	.90						
7	Self-Efficacy	4.96	3.01	.518**	.605**	.595**	.547**	.483**	.496**	.88					
8	Intragroup Trust	5.83	1.48	.590**	.352*	.506**	.522**	.460**	.408*	.324	.88				
9	Information Sharing	5.47	2.20	.787**	.651**	.623**	.654**	.562**	.631**	.501**	.817**	.94			
10	Social Cohesion	5.76	1.62	.711*	.498**	.540**	.527**	.408*	.460**	.342*	.838**	.890**	.86		
11	Subjective Norm	4.78	1.07	.324	.208	.085	.335*	.033	.139	.267	.282	.399*	.281	.67	
12	System Customization	4.50	3.03	.657**	.449**	.547**	.649**	.452**	.443**	.210	.544**	.568**	.487**	.306	.85

** Significant at p<.01; Significant at p<.05 – Internal Consistency Coefficients shown in bold

Table 3. Correlation Matrix and Average Variance Extracted for Principal Constructs (Getting Info)

B. MEASUREMENT VALIDATION

Measure reliability was assessed using internal consistency scores, calculated by the composite reliability scores (Werts, Linn, and Joreskog, 1974).[2] Internal consistencies of all variables are considered acceptable since they exceed .70, signifying tolerable reliability. Convergent and discriminant validity is inferred when the PLS indicators (a) load much higher on their hypothesized factor than on other factors (own-

---

2 The composite reliability score is: $(\Sigma\lambda\iota)2 / [(\Sigma\lambda\iota)2+ \Sigma\iota Var(\varepsilon I)]$, where $\lambda\iota$ is the indicator loading, and $Var(\varepsilon I)=1-\lambda\iota2$.

loadings are higher than cross-loadings), and (b) when the square root of each construct's Average Variance Extracted (AVE) is larger than its correlations with other constructs (the average variance shared between the construct and its indicators is larger than the variance shared between the construct and other constructs (Chin, 1998).The square root of all AVEs are above 0.80, which are much larger than all the cross-correlations. These tests suggest that all measures have adequate convergent and discriminant validity. Common method bias was assessed using Harman's one-factor test (Podsakoff and Organ, 1986). Each principal construct explains roughly equal variance (omitted for brevity), indicating that our data do not suffer from high common method variance. Finally, multicollinearity among the external beliefs was not a serious concern since all checks (eigen analysis, tolerance values, VIF) did not indicate any problem.

C.   THE STRUCTURAL MODEL

The PLS path coefficients (which can be interpreted as standardized regression coefficients) are shown in Figure 2. For clearer exposition, the item loadings of each construct are omitted since they are all above 0.80. All control variables were initially included in the model, but since none were significant, all controls were dropped.
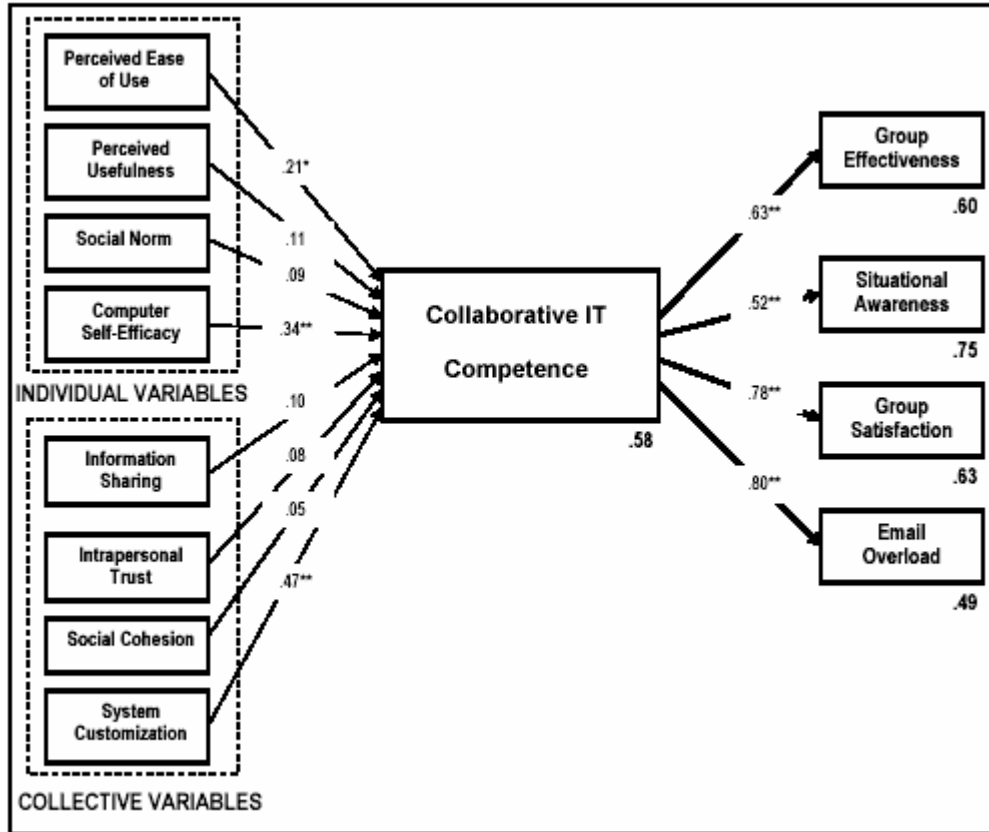
Figure 2.   PLS Results (n=37)

As shown in Figure 2, collaborative IT competence significantly influences all four performance measures, explaining a substantial amount of their variance. In turn, three predictor variables – perceived ease of use, computer self-efficacy, and system customization – influence collaborative IT competence.

D.   DISCUSSION

While we propose eight influencing factors to IT competence, and only three prove to be statistically significant, much of this can be assessed to the limited sample size. There is directional importance to the other variables that a large sample size could provide further evidence to their importance.   This study presents an initial step towards better understanding the individual and collective variables that directly influence collaborative system use.   It also establishes a critical link and feedback loop that includes all stakeholders of the CIT environment process. The net result of this new interaction being decision makers make better informed decisions by effectively empowering every end user to influence their environment by being a part of the process.

Other benefits include the ability to foster and encourage the effective use of collaborative technology as well as provide insight into design enhancements of future collaborative capabilities. The ultimate practical contribution of the final research model then becomes a direct contribution to the eventual CIT universal defense capability and policy. Based on this successful pre-test of the research model, it is recommended the research model/survey tool be used on a significantly larger subject population. This will allow for additional analysis of additional contributing factors that influence collaborative system use.

THIS PAGE INTENTIONALLY LEFT BLANK

V. RECOMMENDATIONS

This research originates out of an initiative to address e-mail overload, however the resultant validated research model illustrates the complexities of the core collaborative functionalities. A better understanding of the critical relationship between Collaborative IT Competence and collaborative functionalities will allow us to influence performance outcomes positively, including reductions in email overload. Although a great deal of research remains to understand and optimize Collaborative IT Competence this preliminary research indicates the use of collaborative tools can increase group productivity, cut down on the amount of extraneous e-mail traffic, and enhance situational awareness and decision-making.

A. RECOMMENDATIONS FOR THE NAVY

The Navy and DoD have spent significant amounts of time and money on what could be termed exploration in CIT. Unfortunately, to this point it has mostly been exploration without good documentations as to the goals and benefits of the use of CIT. Organizations throughout the Navy have deployed various CIT applications assuming they will reap benefits from these implementations without bothering to evaluate what the benefits are going to be. The assumption is things will just be better. While the ability to collaborate virtually through the use IT is one of the pillars for success of the Navy's NCW/IS vision, little has been done to actually structure how this capability will be implemented Navy wide. If the Navy and DoD are truly going to achieve the desired benefits of CIT as envisioned in NCW/IS several key functions need to take place.

Collaboration will continue to influence every level of military operations and in the future will require integration of joint, inter-agency and coalition partners. Technical interoperability alone will not produce a synchronized and effective fighting force. Key allies, other services and government agencies must be included in the development process of Navy network-centric capabilities (NWDC IKA 2004). To this end, step one requires a vigorous program of iterative concept development and experimentation, starting with a complete Navy inventory and assessment of collaborative tools currently in use. A DoN supported study utilizing the research model presented is recommended to empower decision makers with an accurate field assessment based on end-user input.

Based on the results of step one the Navy needs to stop allowing independent activities to choose their own solutions and an enterprise wide solution needs to be adopted with an emphasis on successful implementation of the core functionalities. This would allow entities throughout the Navy to share information across operational and organizational boundaries. The methodology should be based on the full understanding of Collaborative System Use and be specifically targeted at optimizing the utilization of each functionality.

B.   GROUP MANAGERS AND USERS

Training and support on the use of the tools needs to be both robust and interactive in the form of hands on between the users and the developers of the tools we deploy. While many users will find the new tools at their disposal very intuitive and easy to use there may be some who are resistant to them because they involve a change in the way they have conducted their actions in the past. To merely run a system out to the fleet users and allow them to learn by doing without some form of formal training and ongoing support would be irresponsible both fiscally and qualitatively. Without the appropriate level of technical support, many of the users will likely never realize the full potential offered by the new tools within the realm of CIT.

C.   DOD IN GENERAL

In the ongoing war against terrorism, one of the primary areas of interest revolves around the need to coordinate efforts in the realm of intelligence collection and analysis. By infusing interoperable collaborative technologies into all DoD communities, DoD can ensure integration of intelligence efforts and develop enterprise-wide capabilities. By developing a secure, seamless, and interoperable collaborative infrastructure and enabling end-to-end connectivity among all DoD departments, cross-departmental knowledge sharing can take place that would enable sound decisions to be made with up-to-date information, irrespective of rapid changes in the environment.

D.   IMPLICATIONS FOR REDUCTION IN EMAIL OVERLOAD

Email because it has become the tool of choice for so many people and it is so widely accepted, has been adopted for use to a number of environments that it is not ideally suited. Many traditional face-to-face meetings or phone conversations have been replaced by email because of the perceived ease of use. One problem is once the email is

24

fired out the user looses control of the schedule of response. In a dynamic environment, the sender is now bound to his or her computer waiting for a response if the question is time critical. In addition, they have no vision as to when the message will be viewed or that receiver interprets the context of the message correctly. The reality is there are a number of CIT solutions that have been developed that provide a much richer information exchange and better outcomes then the use of email. As demonstrated by the research model there was a strong correlation (.80) for a perceived reduction in email overload. Just as there were those who were resistant to the idea of using email to begin with, there will be those who are resistant to the use and deployment of the new collaborative tools.

The way organizations implement their email systems can be enhanced by the incorporation of other CIT technologies. Based on a case study implementation plan involving the use of CIT the cost savings and increases to productivity may be significant (Housel and Cook 2004). Oracle's Collaboration Suite and their integrated storage repository for all emails in illustration how centralized storage may be beneficial. Where before if a user wanted to keep a copy of a particular email that message was associated with his particular account. If ten members of an organization wanted to keep a message, ten individual copies were stored on the organizations mail servers. With Oracles system one copy is kept, centrally stored, and then accessed by those who require it. This reduces the overall storage requirement for the organization and allows for better version control, tracking, and potentially access control enterprise wide.

F.   FURTHER RESEARCH

The Navy and DoD have invested significant amounts time and money into collaborative tool applications but unfortunately have failed to tap their most valuable resources for performance feedback on these applications. This study presents an initial step towards filling that void. Specifically this research has broad implications for understanding the individual and collective variables that directly influence collaborative system use. This understanding offers many potential benefits including the ability to foster and encourage the effective use of collaborative technology as well as provide insight into design enhancements of future collaborative capabilities. The research model makes a practical contribution towards the eventual CIT universal defense capability and

policy. Given the Navy's express interest in CIT, based on its vision the Navy of the future, continued research and development of this methodology is essential towards the ultimate goal of true net centric warfare.

APPENDIX. MEASURED ITEMS

SURVEY MEASUREMENT ITEMS
PROJECT CHARACTERISTICS
Project Title:
Individuals in Group.
Your Position in the Group:
USE OF COLLABORATIVE SYSTEM (1: strongly disagree/7: strongly agree)
email functionality
chat/messaging functionality
calendar functionality
file-sharing functionality
web conferencing functionality
whiteboard/shared workspace functionality
'smart' search functionality
COLLABORATIVE IT COMPETENCE (1: strongly disagree/7: strongly agree)
Email to exchange messages among team members.
Chat/Instant Messaging to share information in real-time.
Calendar for connecting time and location information for all team members
Scheduling for providing up-to-date calendar information.
File sharing to store, archive, and reuse information and best practices.
Consolidation and synchronization of files into a single repository for easy access.
Conferencing for spawning new ideas and solutions.
Collaboration among team members to interact in real time.
Shared workspace for simultaneously working together in real-time.
Whiteboard functionality for bringing together team members.
Search functionality for quickly locating information and files.
Search functionality for enabling quick access to content.
PERFORMANCE INDICATORS (1: strongly disagree/7: strongly agree)
Project Efficiency
We were able to meet our project timeline deliverables.
We efficiently managed our daily workflow.
Project Effectiveness
Our project deliverables were of high quality.
Improvements in quality of group's activities.
Situational Awareness
Do you have any difficulty finding required items of information?
Do you have a coherent mental picture and good understanding of your project status?
Do you have the feeling that you are able to anticipate problems?
Satisfaction
Your situational awareness.
Satisfaction with the system.
Collaborative System Use
I send fewer emails.
I make fewer phone calls.
I use IM/chat features instead of sending email.
I hold/attend less meetings in-person.
I email less documents/attachments to group members.
Perceived Usefulness
Using the system would enable me to accomplish tasks quicker.
Using the system would improve my job performance
Using the system in my job would increase my productivity.
Ease of Use
My interaction with the system is clear and understandable.
Learning to use the system was intuitive and did not require a lot of my mental effort.

SURVEY MEASUREMENT ITEMS
I find the system to be easy to use.
Computer Self-Efficacy
I could complete my job using the system...
Without assistance.
With on-site assistance initially.
With software manuals for reference.
With assistance or help utility available.
Facilitating Conditions
I have the resources necessary to use the system.
With the proper training and technical support I would be able to use the Collaborative System.
GROUP DYNAMICS
Beliefs in Interpersonal Trustworthiness
We trust each other.
Our promises to each other are reliable.
We are honest in dealing with each other.
We would go out of our way to help each other out.
Information Sharing
I am satisfied with the information and knowledge sharing among group members.
I am comfortable sharing sensitive information within my group.
Social Cohesion
Members are friendly to each other.
Members are committed to maintaining close interpersonal relationships.
Members are committed to group goals and success.
Social Norm
People who influence my behavior think that I should use the system.
People who are important to me think that I should use the system.
ENVIRONMENTAL UNCERTAINTY
Our environment has a high operational tempo.
Our environment is continuously changing.
Environmental changes in our area are difficult to forecast.
CONTROL VARIABLES
System Voluntariness
My use of the system is voluntary.
Using the system is not compulsory to my job.
Given the choice I would choose to use the Collaborative System I now use.
Previous Training, Before Using the System I Received:
No Training
Classroom Training
Online Training
One-on-One Training
Hands-on Training
System Customization
The collaborative system we use adapts to our business processes, rules, and practices.
The collaborative system we use is customized to our specific needs.
Personal Habits
Using a collaborative system has become a habit for me.
Using my existing system has become natural for me.
DEMOGRAPHIC DATA
How many months has your group been using a Collaborative System?
How many years of work experience do you have?
What is your age?
Please provide your email address if you would like a copy of the results of this study.
Gender:
What is your educational level?
What is your current position?
I consider myself a(n) _____ user.

LIST OF REFERENCES

Ajzen, I. "The Theory of Planned Behavior," *Organizational Behavior and Human Decision Processes*, 50, (1991), 179-211.

Ajzen, I. "Constructing a TpB Questionnaire: Conceptual and Methodological Considerations, *Working Paper*, University of Massachusetts, Amherst, (2002). Online: http://www-unix.oit.umass.edu/~aizen/ September 20, 2004.

Armstrong, J. S. and Overton, T. "Estimating Nonresponse Bias in Mail Surveys," *Journal of Marketing Research*, 19, (1976), pp. 396-402.

Bandura, A., *Self-efficacy: The exercise of control,* New York: W.H. Freeman, (1997).

Becerra-Fernandez, I., and R. Sabherwal, "Organizational Knowledge Management: A Contingency Perspective," *Journal of Management Information Systems,* 18, 1, (2001), 23-55.

Bensaou, M., and N. Venkatraman, "Configurations of Interorganizational Relationships: A Comparison between U.S. and Japanese Automakers," *Management Science,* 41, 9, (1995), 1471-1492.

Bharadwaj, A., "A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation," *MIS Quarterly*, 24,1, (2000), 169-196.

Chin, W.W., "Issues and Opinions on Structural Equation Modeling," *MIS Quarterly*, 22, 1, (1998), 7-16.

Churchill, G. "A Paradigm for Developing Better Measures of Marketing Constructs," *Journal of Marketing Research*, 16, 1, (1979), pp. 64-73.

Communication News, "Web Meetings Benefit Bottom Line," *Communication News*, 40, 6, (2003).

Compeau, D. and Higgins, C. "Application of Social Cognitive Theory to Training for Computer Skills," *Information Systems Research,* 6, 2, (1995), 118-143.

Davis, F. D., "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly*, 13, 3, (1989), 319-340.

Easley, R. F., S. Devaraj, and M. J. Crant, "Relating Collaborative Technology Use to Teamwork Quality and Performance: An Empirical Investigation," *Journal of Management Information Systems*, 19, 4, (2003), 247-268.

Endsley, M. R. "Situation Awareness Measurement in Test and Evaluation," In T. G. O'Brien and S. G. Charlton (Eds.), *Handbook of Human Factors Testing & Evaluation* (1996) Mahwah, New Jersey: Lawrence Erlbaum, 159-180.

Feeney, D.F., and L. P. Wilcocks, "Core IS Capabilities for Exploiting Information Technology," *Sloan Management Review*, 39, Spring, (1998)

Fornell, C. and F. Bookstein, "Two Structural Equation Models: LISREL and PLS Applied to Consumer Exit-Voice Theory," *Journal of Marketing Research*, 19, (1982), 440-452.

Grantham, C.E. and L. Nichols, *The Digital Workplace: Designing Groupware Platforms*, Van Nostrand, New York, 1993.

Goodhue, D. L. "Understanding User Evaluations of Information Systems," *Management Science*, 41, 12, (1995), 1827-1844.

Hamilton, S., "A better way to manage product development," *Machine Design*, 73, 16, (2001), 80-86.

Harmon, A., "Staffs Make a Virtue of Necessity," *The New York Times*, (October 29, 2001), C.1.

Housel, T and G. Cook, "Email Overload Study at Fleet Numeric Monterey," Working Paper, (Winter 2004).

Jap, S. D., "Pie-Expansion Efforts: Collaboration Processes in Buyer-Supplier Relationships," *Journal of Marketing Research*, 36, (1999), 461-475.

Jap, S. D., "Perspectives on Joint Competitive Advantage in Buyer-Supplier Relationships," *International Journal of Research in Marketing*, 18, 1 (2001), 19-35.

King, W.R. "IT Capabilities, Business Processes, and Impact on the Bottom Line, Journal of Information Systems, 19, 2, (2002), 85-92.

Kraut, R. and L. Streeter, "Coordination in Software Development," *Communications of the ACM*, 38, (1995), 69-81.

Kusunoki, K., I. Nonaka and A. Nagata, "Organizational Capabilities in Product Development of Japanese Firms: A Conceptual Framework and Empirical Findings," *Organization Science*, 9, 6 (1998), 699-718.

Licklider, J.C.R. and R. Taylor, "The Computer as a Communication Device," *Science and Technology*, (April 1968).

Limayem, M., and S. G. Hirt, "Force of Habit and Information Systems Usage: Theory and Initial Validation," *Journal of the Association of Information Systems*, 4, 3, (2003), 65-97.

Lind, M. and R.W. Zmud, "Improving Interorganizational Effectiveness through Voice Mail Facilitation of Peer-to-Peer Relationships," *Organization Science*, 6, 4, (1995), 445-461.

Lohmoller, J., *Latent Variable Path Modeling with Partial Least Squares*, Heidelberg, Physica-Verlag, (1989).

Mantena, R. and A. Sundarajan, "Market Expansion or Margin Erosion: The Double-Edged Sword of Digital Convergence," *Proceedings of the International Conference on Information Systems*, Barcelona, Spain, 2002, 677-68.

McGrath, M. J., and M. Iansiti, "Envisioning IT-Enabled Innovation," *Insight Magazine*, 2, 10, (1998).

Molloy, S. and C.R. Schwenk, "The Effects of Information Technology on Strategic Decision Making," *Journal of Management Studies*, 32, 3, (1995), 283-311.

Moorman, C. and A. S. Miner, "The Convergence of Planning and Execution: Improvisation in New Product Development," *Journal of Marketing*, 62, 3, (1998), 1-20.

Navy Warfare Development Command, "Gaining the Information and Knowledge Advantage Executive Summary," http://www.nwdc.navy.mil/Concepts/IKA/IKA.aspx, (2004), September 12, 2004.

Nunamaker, J.F., A.R. Dennis and J.S. Valacich, "Electronic Meeting Systems to Support Group Work," *Communications of the ACM*, 34, 7, (1991), 40-61.

Orlikowski, W.J. and C.S. Iacono, "Desperately seeking the "IT" in IT research: A call to theorizing the IT artifact," *Information Systems Research*, 12, 2, (2001), 121-134.

Pavlou, P. A. and O. A. El Sawy, "From IT Competence to Competitive Advantage in Turbulent Environments: A Dynamic Capabilities Model," Under Review in *Information Systems Research*, (2004a).

Pavlou, P. A. and O. A. El Sawy, "Understanding the 'Black Box' of Dynamic Capabilities: A Missing Link to the Strategic Role of IT in Turbulent Environments?" *Under 2nd Round of Review in Management Science*, (2004b).

Podsakoff, P. M. and D. W. Organ, "Self-reports in Organizational Research: Problems and Prospects," *Journal of Management*, 12, 4, (1986), 531-544.

Rai, A., S. A. Lang, and R. B. Welker, "Assessing the Validity of IS Success Models: An Empirical Test and Theoretical Analysis," *Information Systems Research*, 13, 1, (2002), 50-69.

Rockart, J.F. and J.E. Short, "IT in the 1990s: Managing Organizational Interdependence," *Sloan Management Review*, 31, (1989), 7-17.

Ross, J. R., M. R. Vitale, and C. M. Beath, "Develop Long-Term Competitiveness Through IT-Assets," *Sloan Management Review*, 38, 1, (1996)

Sambamurthy, V. and R.W. Zmud, "Research Commentary: The Organizing Logic of an Enterprise's IT Activities in the Digital Era - A Prognosis of Practice and a Call for Research," *Information Systems Research*, 11, 2, (2000), 105-114.

Sethi, R., D. C. Smith and W. Park, "Cross-Functional Product Development Teams, Creativity, and the Innovativeness of New Consumer Products," *Journal of Marketing Research*, 38, (2001), 73-85.

Straub, D.W. "Validating Instruments in MIS Research," *MIS Quarterly,* 13, 2, (1989), pp. 147-169.

Taman, S., "Collaborative IT at the DON; An Overview of the Current Status July 04," DoN CIO Power Point Briefing, July 23, 2004.

Tully, S., "Rebuilding Wall Street," *Fortune*, (October 1, 2001), p92.

Venkatesh, V., Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model," *Information Systems Research*, 11, 4, (2000), 342-365.

Werts, C.E., R. L. Linn, and K. G. Joreskog, "Interclass Reliability Estimates: Testing Structural Assumptions," *Education and Psychological Measurement*, 34, (1974), pp. 25-33.

Wheeler, B.C., A.R. Dennis and L.I. Press, "Groupware Comes to the Internet: Charting a New World," *The DATABASE for Advances in Information Systems*, 30, 3,4, (1999), 8-21.

Wiseman, C., "Strategic Information Systems," Homewood Il: Irwin (1988)

Wold, H., "Partial Least Squares, In N.L. Johnson (Ed.), *Encyclopedia of Statistical Sciences,* New York, Wiley, (1990).

BIBLIOGRAPHY

Arthur, W. B., "Increasing Returns and New World Of Business," *Harvard Business Review*, (July-August 1996).

Arnison L., P. Miller, "Virtual Teams: A Virtue for the Conventional Team," *Journal of Workplace Learning*, 14, 4, (2002), 166-174.

Burnes, G., G. Stroller, "Virtual Private Networking: the Next Revolution in Corporate Productivity," *Computer Technology Review*, 17, 12, (1997).

Foley, J., "Miles to Go," *Information Week,* Iss. 942, (June 2, 2004).

Gaspar, S., "Virtual Teams, Real Benefits," *Network World*, 18, 39, (2001).

Karsten, H., "Collaboration and Collaborative Information Technologies: A Review of the Evidence," *The DATA BASE for the Advances in Information Systems*, 30, 2, (1999).

Majchrzak, A., R. E. Rice, A. Malhotra, N. King, "Technology Adaptation: The Case of a Computer-Supported Inter-Organizational Virtual Team," *MIS Quarterly*, 24,4, (2000), 569-600.

Malhotra, A., A. Majchrzak, R. Carman, V. Lott, "Radical Innovation without Collocation: A Case Study at Boeing-Rocketdyne," *MIS Quarterly*, 25, 2, (2001), 229-249.

Rynecki, D., "Business Goes to War," *Fortune*, (October 15, 2001), p131.

Vick, R. M., "Perspectives on and Problems with Computer-Mediated Teamwork: Current Groupware Issues and Assumptions," *Journal of Computer Documentation*, 22, 2, (1998), 3-22.

Weick, K.E. and K.H. Roberts, "Collective Mind in Organizations: Heedful Interrelating on Flight Decks," *Administrative Science Quarterly*, 38, 3 (1993), 357-381.

Zahra, S.A. and G. George, "Absorptive Capacity: A Review, Reconceptualization, and Extension," *Academy of Management Review*, 27, 2, (2002), pp. 185-203.

THIS PAGE INTENTIONALLY LEFT BLANK

INITIAL DISTRIBUTION LIST

1.   Defense Technical Information Center
      Ft. Belvoir, Virginia

2.   Dudley Knox Library
      Naval Postgraduate School
      Monterey, California

3.   Marine Cops Representative
      Naval Postgraduate School
      Monterey, California

4.   Director, Training and Education, MCCDC, Code 46
      Quantico, Virginia

5.   Director, Marine Corps Research Center, MCCDC, Code C40RC
      Quantico, Virginia

6.   Marine Corps Tactical Systems Support Activity (Attn: Operations Officer)
      Camp Pendleton, California

7.   Department of the Navy, CIO
      Alexandria, Virginia

8.   D. C. Boger
      Naval Postgraduate School
      Monterey, California